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Materiel Test Procedure 6-4-001
Yuma Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
ENVIRONMENTAL TEST PROCEDURE

DESERT (FIELD) ENVIRONMENTAL TESTING OF COMMUNICATION, SURVEILLANCE, AND AVIONIC ELECTRONIC EQUIPMENT

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a means of evaluating the capability of electronic equipments (communication, surveillance, and avionic electronics) to function effectively against all known conditions in the desert which might have significant effects on the performance characteristics of the equipment.

2. BACKGROUND

Each item developed and produced for the Army must perform satisfactorily in any of the world's environments. Some of the most extreme natural environments are found in the desert.

Electronic equipment stored, transported, and used in the desert experiences conditions and stresses peculiar to this type of environment. These conditions and the stresses arising from them are the results of the climatic and geophysical environments of a desert. For a detailed discussion on the terrain and its associated features, see MTP 10-1-003. Because of such unique stresses, the results of these types of desert environmental tests are not directly comparable to those made during prior engineering and service tests. Interactions of desert environmental factors affect electronic equipment in such a way that it is not always possible to predict their performances from the results of tests conducted in other climates or simulated hot-dry environments. These desert field tests are therefore indispensable for evaluation of the suitability of an item intended for use in desert areas of the world.

3. REQUIRED EQUIPMENT

a. Vehicles (cargo).
b. General and special tools and ancillary items required for inspection, repairs or maintenance on the test item.
c. Test equipment (to monitor environmental conditions and to test components and systems).
d. Still and motion picture cameras with associated photographic equipment (black and white or color).
e. Meteorological support instrumentation.

4. REFERENCES

A. AR 70-8, Human Factors and Social Sciences Research.
B. AR 70-10, Army Materiel Testing.
C. AR 705-5, Army Research and Development.
D. AR 750-6, Maintenance Support Planning.
E. AR 70-38, Research Development Test and Evaluation of Materiel for Extreme Climatic Conditions.

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F. USATECOM Regulation 350-6, Training in New or Modified Equipment and Training Devices.
G. USATECOM Regulation 705-2, Documenting Test Plans and Reports.
H. MTP 2-4-001, Desert Environmental Test of Wheeled and Tracked Vehicles.
I. MTP 6-2-502, Human Factors Engineering.
J. MTP 6-2-507, Safety.
K. MTP 10-3-500, Preoperational Inspection and Physical Characteristics.
L. MTP 10-4-001, Desert Environmental Testing of General Supplies and Equipment.
M. MTP 10-1-003, Desert Terrain.

5. SCOPE

5.1 SUMMARY

This MTP describes in general terms the preparation, conduct, recording, and reporting methods to be used for desert environmental testing of communication, surveillance, and avionic electronic equipment.

Because of the wide scope and similarities existing among the equipment being considered, two approaches are used in the testing procedures. Exposure tests are based on component items and subsystems. System Performance/Capability tests are approached from the standpoint of a complete assembly or system. The test procedures described in this MTP aim to evaluate the primary technical characteristic of the equipment as influenced by the desert environment. These tests should reveal deficiencies and identify the cause of such deficiencies.

The specific tests to be performed, along with their intended objectives, are listed below:

a. Inspection - The objective of this subtest is to determine:

1) The overall physical condition of the test item arriving at the testing installation.
2) If the test items are complete. This includes ancillary equipment and maintenance packages.
3) If the test item is correctly assembled, properly labeled, and ready for test.

b. Exposure - The objective of this subtest is to determine the effects of desert environmental expsoure to communication, surveillance, and avionic electronic components and subsystems during transport and storage phases.

c. System Performance/Capability - The objective of this subtest is to determine the capability of communication, surveillance, and avionic electronic systems to perform in a desert (field) environment.

d. Security from Detection - The objective of this subtest is to determine the capability of communication, surveillance, and avionic electronic equipment to avoid detection when operated in a desert (field) terrain.

e. Maintenance Evaluation - The objective of this subtest is to

determine the maintenance requirements for the test items in a desert (field) environment.

f. Human Factors - The objective of this subtest is to determine the effectiveness of human factors aspects of communication, surveillance, and avionic equipment during desert (field) testing.

g. Safety - The objective of this subtest is to determine if the test items are safe for use in a desert environment.

5.2 LIMITATIONS

This MTP deals with field testing and no specific instructions are provided for performing tests in simulated environments or other induced hot-dry conditions.

The material in this MTP does not constitute complete or detailed test plans but a test plan for desert environmental testing of specific electronic items may be developed from the general procedures outlined in this MTP.

Supplementry information may be obtained from MTP 2-4-001, and MTP 10-4-001.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Select test equipment ideally having an accuracy 10 times greater than that of the function to be measured.

b. Record the following information:

1) Nomenclature, serial number(s), and manufacturer's name of the test item.
2) Nomenclature, serial number(s), accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.
3) Date equipment was packed.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the equipment under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC), and record this criteria in the test plan.

d. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test conduct.

e. Prepare record forms for systematic entry of data, chronology of tests, and analysis in final evaluation.

f. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous tests conducted on the same type of equipment, and familiarize all test personnel with available references.

g. Record the grade, MOS, background, and training of all test personnel and ensure that all personnel receive new equipment training (NET).

h. Verify that test facilities, equipment and accessories are available, operational and properly calibrated. Power sources shall be checked to ensure correct outputs.

i. Record the prevailing meteorological conditions as required, during test conduct, to include:

1) Temperature.
2) Humidity, relative or absolute.
3) Temperature gradient.
4) Atmospheric pressure.
5) Precipitation.
6) Solar radiation.
7) Wind speed and direction.

6.2 TEST CONDUCT

NOTE: A detail discussion of desert test conditions is contained in MTP 10-1-003.

6.2.1 Inspection

NOTE: Unless otherwise defined by Technical Characteristics (TC's) QMR's, SDR's, the following inspection sequence should be performed. (Reference MTP 10-3-500).

a. Select an identification number before inspection.
b. Place identification number on the container.
c. Inspect the individual containers in accordance with Appendix A.
d. Remove the test item from the container.
e. Transfer the identification number to the test item.
f. Subject all test items, components and accessories to a thorough visual inspection to determine the existence of any damage or deficiency that precludes or degrades test item operation.
g. Correct as many deficiencies as possible. If a critical defect cannot be remedied, remove the item from test.
h. Repack test items in accordance with appropriate packaging procedures.

6.2.1.1 Operational Functions

a. Subject the test item to a basic operational test as required during the test cycle.
b. Perform such adjustments and inspections as may be required by the test item specification.

6.2.2 Exposure

NOTE 1: The procedures described below are based on the movement of electronic equipment from the communication zone to the user. Figure 1 is a logical flow of material. Prior to the communication zone, it is assumed that

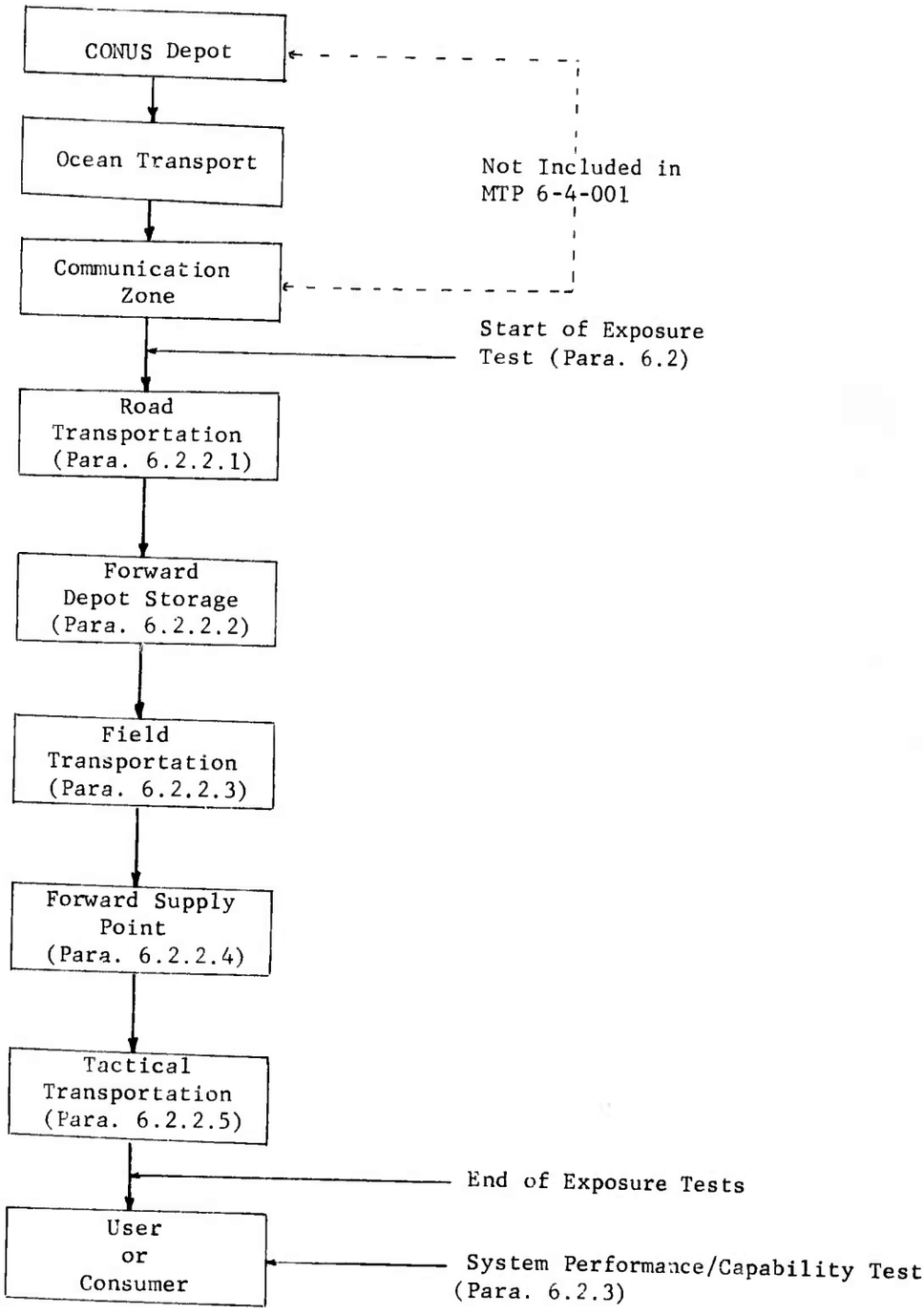

FIGURE 1 Stockpile-to-Use Flow of Electrical and Electronic Equipment

material is maintained at a temperate environment while in CONUS and subsequently a maritime environment while transporting overseas. These prior conditions are not covered in this MTP.

NOTE 2: Exposure tests are based on component items and sub-assemblies (the term "component parts" as used in this test includes such items as listed in Appendix B).

6.2.2.1 Road Transportation

a. Instrument the test item to obtain the following information:

1) Container interior air temperatures.
2) Average test item skin temperatures.
3) Temperature of critical components.
4) Triaxial acceleration of test items.
5) Triaxial acceleration of critical components.
6) Input shock and vibration conditions (waveforms, amplitude, and duration).

b. Load the test item onto a suitable cargo transport vehicle.

NOTE: Test item shall be packaged according to normal practice.

c. Maintain a critical observation of handling experiences occurring during the various sequences of vehicle loading, unloading, unpacking, storage and emplacement.

d. Transport the test item from the communication zone to the forward depot storage area. (Reference mileage requirements in Appendix C).

e. Upon arrival at the forward depot storage perform the following on the test item:

1) Visual inspection for signs of damage.
2) Basic operational test to verify satisfactory operation of the test item.

NOTE: Deficiencies shall be corrected before proceeding with the test.

6.2.2.2 Forward Depot Storage

a. Place the test item in storage. (Reference Exposure Requirements in Appendix C).

b. Note and record storage location and environment.

c. Instrument the test item to obtain the following information:

1) Overpack skin temperature.
2) Container skin temperature.
3) Container interior air temperature.
4) Maximum test item skin temperature.
5) Average test item skin temperature.
6) Temperatures of critical components.
7) Temperature of the ambient air.

8) Ground temperature.

d. Photograph the storage conditions and instrumentation set-up.

e. Upon removal from storage prior to field transport perform the following on the test item:

1) Visual inspection for signs of damage.
2) Basic operational test to verify satisfactory operation of the test item.

6.2.2.3 Field Transportation

a. Repeat the procedure outlined in steps a, b and c of 6.2.2.1, above.

b. Transport the test equipment from the depot storage to the forward supply point. (Reference mileage requirements in Appendix C).

c. Repeat the procedure outlined in step e of 6.2.2.1.

6.2.2.4 Forward Supply Point

a. Place the test equipment in storage. (Reference Exposure Requirements in Appendix D).

b. Note and record storage location and environment, as in step b of 6.2.2.2.

c. Repeat the procedures outlined in steps c through e of 6.2.2.2.

6.2.2.5 Tactical Transportation

a. Repeat the procedures outlined in steps a, b and c of 6.2.2.1, above.

b. Transport the test equipment from the forward supply point to the user or consumer. (Reference mileage requirements in Appendix E).

c. Repeat the procedures outlined in steps c through e of 6.2.2.2 above.

6.2.3 System Performance/Capability

a. Remove test equipment from containers.

b. Inspect test equipment visually, for damage sustained in exposure tests in accordance with Appendix G and paragraph 6.2.1, inspection.

c. Connect components into their normal system configuration.

d. Perform such other preparatory steps as may be specified in the applicable commodity MTP's such as preliminary operational checks and/or self-test operations.

e. Operate the system (in accordance with applicable documentation) so that all operational states are exercised and observe the performance of the test item during these tests.

f. Monitor the environmental conditions throughout the conduct of the system tests and time correlate the environmental data with performance data.

6.2.4 Security From Detection

NOTE: The security from detection subtest may be conducted during the test item's emplacement while undergoing System Performance/ Capability tests.

a. Select test sites typical of the worlds deserts and providing suitable background conditions, reference MTP 10-1-003. (See Appendix F for landscape types and dominant colors in desert terrain).

b. Paint the test items in accordance with colors listed in Appendix F.

NOTES: 1. The dominant color should be tan, with earth brown used to break up shapes or patterns.
2. If netting is used for camouflage, garnish should be provided for desert terrain.

c. With the test equipment sited or emplaced, remove any sand or other displaced natural material and observe the camouflage and concealment qualities of the test equipment as situated in the following terrain types.

1) Open desert pavement, no cover.
2) Rocky or boulder strewn desert, no vegetation.
3) Terrain having xerophyte vegetation (non-succulent).
4) Surfaces composed of loose or drifted sand.

d. Observe the extent to which blowing sand and surface finish changes associated with abrasion or solar radiation degrade or improve concealment in the above locations.

e. Observe signature effects such as tracks, operational noise, dust clouds, flash smoke, acoustic radiation shadows, etc., during transport, emplacement and actual use of the items under test.

NOTE: Observations concerning camouflage and concealment shall be made with observers positioned at ranges of 500, 1000, and 3000 meters, within line of sight. In cases of test item emplacements greater than 4 sq. yards, observations shall be made from the ground and from elevated positions.

f. Monitor visibility conditions such as the following:

1) Atmospheric clarity (freedom from dust and haze).
2) Sky conditions (cloud cover).
3) Elevation of the sun (time of day and date).

NOTE: Observations taken during this subtest, shall be made utilizing color film and suitable still photographs, if possible.

6.2.5 Maintenance Evaluation

a. Investigate the effects of the desert environment on maintenance conditions and procedures during the cycles of organizational maintenance re-

quired in connection with exposure and system performance tests.

b. Observe actions necessary to ensure serviceability of the equipment under test as the equipment is removed from storage, or off-loaded from transportation, or assembled for system performance.

c. Investigate the requirements for non-standard tools, equipment, supplies and instructions needed to accomplish necessary maintenance, which were not furnished with the equipment under test.

6.2.6 Human Factors

a. Observe difficulties encountered in handling, operating, assembling, disassembling the equipment under test. (Refer to MTP 6-2-502).

b. Prepare a human factors questionnaire, see Appendix H.

6.2.7 Safety Tests

a. Prior to committing test items to exposure and performance, review applicable safety statement or safety release and examine all test items for conformity and for presence of other hazardous conditions (refer to MTP 6-2-507).

b. In addition to the above, prepare a safety checklist to include safety procedures, precautions, protection, see Appendix I and emergency procedures as necessary. Other pertinent information such as the technical information or the technical hazards and safety characteristics, analysis of risks, limitations, and precautions including special techniques and test equipment should be included in the safety checklist.

c. Ensure that all safety procedures are followed throughout the conduct of the test cycle in accordance with the safety plan, and note the observations during each of the subtests given in this MTP:

NOTE: Observations regarding safety shall be observed continually during the entire test cycle. Photographs (black and white or color) shall be made of deficiencies whenever possible.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include but not be limited to:

a. Nomenclature, serial number(s), manufacturer's name and function of the item(s) under test.

b. Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

6.3.2 Test Conduct

In addition to the specific data requirements delineated in subsequent

paragraphs, the following items shall be preserved as a part of the test records:

a. An engineering logbook containing in chronological order, pertinent remarks and observations which will augment test data and support engineering evaluation and analysis of the technical performance of the test item.

b. Supporting photographs, calibration records, and recordings of test anomalies or deviations from the test plan made where necessary.

6.3.2.1 Inspection

a. Inspection data shall be recorded as described in MTP 10-3-500 paragraph 6.3.2 (arrival inspection).

b. Record the temperatures of the items under test as follows:

1) Container interior air temperatures.
2) Average test item skin temperatures.
3) Container skin temperatures.
4) Temperature of critical components.

c. Provide a description of the test site. Record the results of arrival inspection performed after each road, field and tactical transportation phase.

d. Record determinations of the following during the storage and system performance phase:

1) Location and extent of dust accumulation within the test item.
2) Deterioration, corrosion, or changes in performance tolerance limits of any components.

e. All significant damage shall be noted and photographed so as to show clearly its nature and extent.

6.3.2.1.1 Operational Functions

a. After each operational check conducted during or after exposure perform a detailed visual inspection and record determinations of the following:

1) The ability of the test items to function properly during and after exposure.
2) Short circuits, or the leaking of current to ground in electrical components caused by dust deposits.
3) Location and extent of dust accumulation within the equipment.
4) Degradation of bearings, grease seals, lubricants, cooling, systems, etc. resulting from exposure.
5) Deterioration, corrosion, or changes in performance tolerance limits of any component or exposed internal part.

6.3.2.2 Exposure

a. A full description of the test site is required.
b. Record all evidences of deterioration, including location on test item, probable effects of deterioration on test item performance, and action taken to alleviate the condition.
c. Record all deficiencies attributal to exposure.

6.3.2.3 System Performance/Capability

Record performance system data during tests. Record environmental data and correlate with performance data.

6.3.2.4 Security from Detection

Record the observed camouflage and concealment qualities possessed by the test equipment for each of the terrain types selected for the test.

6.3.2.5 Maintenance Evaluation

a. Record actions taken to ensure serviceability of the test equipment under test.
b. Record the following aspects of maintenance:

1) Ease of performing required maintenance.
2) Special tools or skills required.
3) Interchangeability of components.
4) Adequacy of instructional manuals.
5) Photographs as necessary.

6.3.2.6 Human Factors

Complete Human Factors Questionnaire Appendix H after completion of approximately 1/3 of the total operating hours used on this test, and at the completion of the test.

6.3.2.7 Safety Tests

Safety data to be recorded for analysis shall include but not be limited to data as indicated in MTP 6-2-507.

Complete safety checklist in Appendix I.

6.4 DATA REDUCTION AND PRESENTATION

a. Processing of raw test data, in general, includes but is not limited to the following steps:

1) Marking test data for identification and correlation.
2) Organizing data into tabular and graphical form.

3) Modifying data to correct for nonstandard conditions.
4) Determining the statistical variation of the results in terms of the average value and standard deviation of the particular quantities, the correlation among two or more quantities, etc.

b. It is noted that the test directive (or operation) itself serves to define the types and characteristics of the raw test data, and the ultimate objective of the test program defines the form of the test data desired.

c. Specific instructions for the reduction and presentation of individual subtest data are outlined in subsequent paragraphs.

6.4.1 Inspection

a. Data recorded for individual components shall be retained for the evaluation of the test equipment after exposure and system performance tests.

b. Inspection data shall also be summarized and presented as:

1) Percent total defective.

a) Overpacks (based on total number of overpacks).
b) Containers (based on total number of test sub-assemblies).
c) Unassembled parts (based on total number of test items).

2) Percent critical deficiencies.
3) Percent major deficiencies.
4) Percent equipment under test without any deficiencies.

6.4.2 Exposure

a. Prepare graphic and narrative presentations, as required to illustrate circumstances relating to malfunctions and failures attributed to desert environmental stresses.

b. Compare values from presentations with prescribed or desired values, tolerances, etc., and determine the acceptability of the test item in this regard.

6.4.3 System Performance/Capability

Present the data in narrative or tabular form as appropriate.

6.4.4 Security From Detection

Present the data in a narrative statement of results of the observations relating to security from detection.

6.4.5 Maintenance Evaluation

Observations shall be summarized and presented in narrative form.

Where necessary, the narrative shall be supplemented by line drawings and photographs.

6.4.6 Human Factors

a. Present in narrative form evaluation of questionnaire.
b. Utilize still and motion picture frame illustrations, and graphical summaries as applicable.

6.4.7 Safety Tests

Observations and deficiencies shall be presented in narrative form, supplemented as required by line drawings and photographs.

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APPENDIX A

Inspection Checklist

Individual Containers

Failures

Type of Inspection	Code	Description	Initial Inspection (Para. 6.2.1)	After Exposure Mode	Before Functioning
	Major				
Visual	2201	Packing of Components.	X	-	-
Visual	2202	Container cut or broken, contents exposed.	X	X	X
Visual	2203	Ends loose or distorted.	X	X	X
Visual	2204	Seals incomplete, broken, or wrinkled.	X	X	X
	Minor				
Manual	2301	Contents loose.	X	X	X
Visual	2302	Markings misleading or illegible.	X	X	X
Visual	2303	Cuts, scuffs, or gouges in outer layers.	X	X	X
Manual	2304	Tear tab length inadequate.	X	-	-
Visual	2305	Gap between cover and body greater than 1/8 in.	X	-	X
Manual	2306	Cap cannot be removed by hand.	X	-	X
Manual	2307	Item cannot be removed by hand.	X	-	X
Visual	2308	Item improperly assembled in container.	X	-	-

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APPENDIX B

COMPONENT PARTS

a. Resistors - High temperatures cause most resistors to fail rapidly. Both reversible and irreversible resistance changes take place. Within the temperature range of -67°F to +77°F (-55°C to +25°C), the resistance of wire wound resistors usually varies less than 1 percent. The actual extent of resistance change for any particular resistor depends on its nominal value and the material making up the resistor. High temperatures cause the lubricants used in the variable resistors to dry up, ooze out, or move from the bearings to other surfaces.

b. Capacitors - Generally, high temperatures result in decomposition and dielectric failure in electrolytic and paper capacitors, temperature rises cause increased dc leakage current in electrolytic capacitors. This in turn results in increased heating and drying out of the electrolyte or of the container. Also, high temperature can lead to rupture of the electrolyte or of the container. Air capacitors on the other hand are less affected by high temperature. Variable air capacitors, like others, are affected by loss of lubricants.

c. Transformers - The life of a transformer is reduced by high temperature as a result of deterioration of its insulation, loss of coolants, and consequently increased heating. The resistance of the windings increases resulting in changes of its characteristics as the temperature increases to a high value.

d. Electron Tubes - High temperature can result in grid emission and release of gas from other tube elements. Electrolysis of leads coming through the glass envelope can also occur. Thus, the operating point of a tube at high temperature can be markedly different from that at normal temperature operation. This has a deleterious effect on other components.

e. Rotating Devices - Lubricants creep, ooze, or evaporate at high temperature, resulting in bearing failure. Commutators and slip rings deteriorate more rapidly and ascending resistance increases, thus causing fluctuations of voltage levels. Synchros, resolvers, and gyros exhibit a decreased accuracy.

f. Circuit breakers and relays - Both magnetic and thermal circuit breakers trip at lower currents than at normal temperatures. Thermal circuit breakers are affected more. Corrosion and expansion result in stuck toggles or jammed detents in switches and relays.

g. Inductors and Magnetic Devices - High temperatures cause current increase from normal operation which in turn results in change of inductance values. The material expansion also plays an important part in the change of the nominal value.

h. Semiconductor Devices - As temperature rises, semiconductors become increasingly unreliable. The trend toward miniaturization and greater power output also accentuates heat intensity problem. Miniaturization leads to an increased concentration of thermal energy. The result is an increased heat density from 0.5 watt to 3.0 watts per cubic inch, with an average of about 1 watt per cubic inch. This is at normal operating conditions at high temperature, the heat problem is compounded.

i. Miscellaneous - Grease, protective compounds, wax, and other soft organic low-melting materials become soft and flow as temperature approaches a high value. Deterioration of cellulose insulation begins at about 100°C (212°F) with an increase in power factor and a decrease in dielectric strength. Long

range processes are accelerated. Differential expansions result in distortion of assembly.

The following Table gives a summary of some electrical and electronic components.

Table B-1 FAILURE MODES OF ELECTRONIC COMPONENTS

Component	Vibration Effects	Shock Effects	Temperature Effects	Humidity Effects	Salt Spray Effects	Storage Effects
Blowers	Brinelling of bearings		Shorts; lubricant deterioration	Corrosion	Corrosion	Lubricant deterioration
Capacitors:						
ceramic	Increased lead breakage; piezoelectric effect; body and seal breakage	Lead breakage; piezoelectric effect, body and seal breakage	Changes in dielectric constant and capacitance; lowered insulation resistance with high temperature		Corrosion; shorts	Decreased capacitance, silver-ion migration
electrolytic	Increased lead breakage; seal damage; current surges	Lead breakage; seal damage; current surges	Increased electrolyte leakage; shortened life; increased current leakage; large change in capacitance; increased series resistance with low temperature	Decreased insulation resistance; increased dielectric breakdown; increase in shorts	Corrosion; shorts	Electrolyte deterioration; shortened life; increased chances for explosion; shorts
mica	Lead breakage	Lead breakage	Increased insulation resistance; silver ion migration; drift	Silver migration	Shorts	Change in capacitance
paper	Increase in opens and shorts; lead breakage	Opens; increased dielectric breakdown; shorts; lead breakage	Changes in capacitance; increased oil leakage; decreased insulation resistance; increased power factor	Decreased insulation resistance; increased power factor	Shorts	Decreased insulation resistance; increased dielectric breakdown; increase in shorts
tantalum	Opens; shorts; current surges; lead breakage	Opens; lead breakage;	Electrolyte leakage; change in capacitance; insulation resistance; series resistance	Decreased insulation resistance; increased dielectric breakdown; increase in shorts	Corrosion	Electrolyte leakage; decreased insulation resistance; increase in shorts

Table B-1 (cont'd) **FAILURE MODES OF ELECTRONIC COMPONENTS**

Component	Vibration Effects	Shock Effects	Temperature Effects	Humidity Effects	Salt Spray Effects	Storage Effects
Choppers	Increase in phase angle and dwell time	Contacts open; change in phase angle and dwell time	Decrease in phase angle; variation in dwell time		Corrosion	Change in phase angle
Circuit breakers	Premature activation	Premature close or open	Failure to function; premature function	Corrosion	Corrosion	Change in characteristics
Clutches, magnetic	Creep	Intermittent operation	Hot spots in coil	Falloff in torque	Binding	
Coils	Loss of sensitivity; detuning; breaking of parts, leads, and connectors	Lead breakage; detuning; loss of sensitivity	Warping, melting; instability; change in dielectric properties	Electrolysis; corrosion	Corrosion; electrolysis	
Connectors:						
standard	Separation of plugs and receptacles; insert cracks; opening of contacts	Opening of contacts	Flashover, dielectric damage	Shorts; fungus; corrosion of contacts; lowered insulation resistance	Corrosion	Deterioration of seals; corrosion of contacts
interstage	Insert cracks; opening of contacts	Opening of contacts	Flashover, dielectric damage	Shorts; fungus; corrosion of contacts; lowered insulation resistance	Corrosion	Deterioration of seals; corrosion of contacts
Crystals	Opens	Opens	Drift, microphonic	Drift		Drift
Crystal holders	Intermittent contact	Intermittent contact		Change of capacity		
Diodes	Opens	Opens	Change in voltage breakdown; increased current leakage; increase in opens and shorts	Increased current leakage	Corrosion of lead and case	Increased current leakage

Table B-1 (cont'd) FAILURE MODES OF ELECTRONIC COMPONENTS

Component	Vibration Effects	Shock Effects	Temperature Effects	Humidity Effects	Salt Spray Effects	Storage Effects
Gyros	Drift	Drift; leaks	Drift			Induced drift
Insulators	Cracking; elongation	Cracking	Epoxy cracking; ferrite separation (arcing); moisture condensation (insertion loss)	Moisture condensation (insertion loss); reduction in dielectric strength and insulation resistance	Reduction in dielectric strength and insulation resistance	
Joints, solder	Cracking; opens	Cracking; opens	Loss of strength	Fungus	Corrosion	At room temperature, strength increased; at low temperature, strength decreased
Magnetrons	Arcing; "FM"-ing	Seal breakage		Arcing	Corrosion	Leaks; gassiness
Motors	Brinelling of bearings; loosening of hardware		Shorts; opens; deterioration of lubricants	Binding of bearings; shorting of windings; corrosion	Corrosion binding of bearings	Oxidation
Potentiometers	Increased noise; change in torque and linearity; wiper brush bounce; open circuit	Increased noise; change in torque linearity, and resistance; open circuit	Increased noise; change in torque, linearity, and resistance; decreased insulation resistance with high temperature	Increased noise; change in torque, linearity, and resistance; decreased insulation resistance	Decreased insulation resistance; increased corrosion; binding	Increased noise; change in torque, linearity, and resistance; decreased insulation resistance
Relays	Contact chatter	Contact opening or closing	Open or shorts; decreased insulation resistance with high temperature	Decreased insulation resistance	Corrosion of pins	Oxidation of contacts causes open circuits; decreased insulation resistance

Table B-1 (cont'd) FAILURE MODES OF ELECTRONIC COMPONENTS

Component	Vibration Effects	Shock Effects	Temperature Effects	Humidity Effects	Salt Spray Effects	Storage Effects
Resistors	Lead breakage; cracking	Cracking; opens	Increased resistance; opens; shorts	Increased resistance; shorts; opens	Change in resistance, lead corrosion	Change in resistance
Resolvers	Intermittent brush operation; brinelling of bearings, cracking of terminal board; loosening of hardware	Intermittent brush operation; cracking of terminal board; loosening of hardware	High breakaway voltage, shift in electrical axis; opens; shorts; deterioration of lubricants	Corrosion that causes expansion and blistering of potting compound; shorting of winding; pinion corrosion	Corrosion; binding	Oxidation; deterioration of lubricants
Servos	Brinelling of bearings; loosening of hardware; cracking of terminal board	Loosening of hardware; cracking of terminal board	Oil throw-out, breakdown of grease; high breakaway voltage	Corrosion that causes blistering of potting compound; shorting of winding; pinion corrosion	Corrosion that causes rotor binding; salt crystals in bearings and on motor	Deterioration of grease with age; oxidation of brushes and slip rings
Switches	Contact chatter	Contact opening	Oxidation of contacts	Pitted contacts; arcing	Oxidation and corrosion; pitted contacts	Oxidation of contacts
Synchros	Intermittent brush operation; cracking of terminal board; brinelling of bearings; loosening of hardware	Intermittent brush operation; cracking of terminal board; brinelling of bearings; loosening of hardware	High breakaway voltage	Corrosion that causes expansion and blistering of potting compound; shorting of winding; pinion corrosion	Corrosion	Oxidation
Thermistors	Lead breakage; case cracking; open circuit	Lead breakage; case cracking; open circuit	Increased shorts and opens	Change in resistance	Lead corrosion; change in resistance	Change in resistance

Table B-1 (cont'd) **FAILURE MODES OF ELECTRONIC COMPONENTS**

Component	Vibration Effects	Shock Effects	Temperature Effects	Humidity Effects	Salt Spray Effects	Storage Effects
Transformers	**Shorts: opens; modulation of output**	**Shorts; opens; modulation of output**	**Reduced dielectric; opens; shorts; hot spots; malformation**	**Corrosion; fungus; shorts; opens**	**Corrosion; shorts; opens**	**Deterioration of potting and dielectric**
Transistors	**Opens; functional disintegration**	**Opens; seal breakage**	**Increased leakage current; changes in gain; increases in opens and shorts**	**Increased leakage current; decreased current gain. If sealed, no effect**	**Increased leakage current; decreased current gain. If sealed, no effect**	**Seal leakage; changes in parameters**
Tubes, electron	**Opens; shorts; microphonics; loosening of elements; changes in characteristics**	**Opens; shorts; changes in characteristics**	**Shorts; temporary change in characteristics; formation of leakage paths; increased contact potential; shorting of heater life, gassiness; bulb puncture**	**Change in characteristics; leakage path; arcing**	**Shorts; corrosion; leakage path; arcing**	**Change in characteristics; leaks; gassiness**
Vibrators	**Intermittent**	**Intermittent**	**Lag**	**Case corrosion**	**Case corrosion**	**Decrease in frequency**

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APPENDIX C

Exposure Requirements

Supply Class and Type *	Road Trans (mi)	Fwd Depot Storage (days)	Field Trans (mi)	Fwd Supply Point (days)	Tactical Movement		
					Sandy Desert	Gravelly Desert	Rocky Desert
Class II Organic to Units (Component Parts)	50 paved plus 150 Secondary	70	35	10	70	130	75
Class IX Special Equipment (Subsystems)		120	35	30	70	130	75

*See Appendix B Classification of some electrical and electronic components

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APPENDIX D

Forward Supply Point Exposure Requirements

Minimum number of days storage to include days with temperature in excess of:

Class and Type of Material	Forward Supply Point (days)	Air Temperature	Ground Temperature	
		105°F for 4 hr	110°F for 2 hr	135°F for 4 hr
Class II Component Parts (organic to Units)	10	7	3	7
Class IX Subsystem (special equipment)	30	25	5	20

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APPENDIX E

Mileage Requirements for Tactical Transportation Subtests

Type Vehicle (1)	Light Tactical (3)			Heavy Tactical (4) or Utility (5)			Combat Vehicle		
Type of Desert (2) Components	Stony	Gravelly	Sandy	Stony	Gravelly	Sandy	Stony	Gravelly	Sandy
Mountains	15	-	5	7	-	3	15	-	5
Badlands/Hills	20	15	5	10	15	4	20	25	5
Fan/Wash	15	15	-	8	15	-	15	25	-
Plains/Flats	20	35	25	10	35	10	20	60	25
Dunes/Fields	-	5	35	-	5	18	-	10	35
Dust	-	5	5	-	5	5	-	10	5
Total	70	75	75	35	75	40	70	130	75

NOTES:
1. Vehicle types are determined from Appendix G.
2. See MTP 10-1-003 for a discussion of desert types and components.
3. Light tactical vehicle transport, most electrical and electronic equipment can be routed by this mode.
4. Heavy tactical or utility vehicle transport, heavy or bulky items such as radar equipment use this mode of transport.
5. Organic or vane type electrical and electronic equipment such as field computer or generator whose transport is organic to the equipment.

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APPENDIX F

Landscape Types for Desert Testing

Desert Flats

Hills/Badlands

Fan/Wash Complex

Mountains

Sand Fields and Dunes

Dominant Colors in Desert Terrain

Terrain Type	Color USA Std.	Munsell Symbol	ISCC-NBS No./Desig.
Barren areas, bare rock shallow high mountain soils	Earth Brown	1.0 yr, 3/2	81 d. gy. y Br
Desert alluvial and sedimentary deposits, sand and thin mountain soils	Tan	7.5 yr, 6/6	57 I. Br
Mountain soils of desert highlands	Earth Red	2.5 yr, 4/6	54. Br O

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APPENDIX G

INSPECTION CHECKLIST

Receiving	Exposure		Functioning	
	Before	After	Before	After
Integrity of: Overpack Packing Packaging Legibility of Markings Source Records Condition of items: Conformance with Specifications Weights Critical Dimensions	Integrity of: Packing Packaging Condition of Items: Identifying Number Serviceability	Integrity of: Packaging Condition of Items: Loose Parts Separated Parts Dents Fractures Accumulations of dust or other foreign matter Identifying Number	Conditions of Items: Serviceability Safe Condition Weights, Critical Dimensions Identifying Number	Condition of Failed Items; Observable Causes of Failure Condition of Spent Items: Signs of Abnormal Functioning

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APPENDIX H

Human Factors Questionnaire

GENERAL: **This form is to be completed by each individual after completion of approximately 1/3 of the total operating time of this test, and again at the completion of the test.**

NAME: _____ DATE: _____

TEMPERATURE RANGE: _____

1. Did you encounter any of the following conditions (circle one phase sub-number if you encountered it).

HUMAN FACTOR	POSSIBLE CONDITION
2.1 Heat Stress	Any symptoms of incipient heat stroke? Any symptoms of incipient heat exhaustion? Any occasions when heat-induced fatigue delayed or curtailed operations? Rate heat encountered in operation of the test item as compared with a similar standard: Cooler, hotter, much hotter? Comfortable, uncomfortable, severe, intolerable? What standard vehicle?
2.2 Burning Temperatures	Any encounters with painfully hot parts? What parts? Specify. Classify as frequently used controls, occasionally used controls or handholds, normally accessible parts, or infrequently touched parts. Any burns suffered: First, second, or third degree?
2.3 Ventilation	Does air become uncomfortably dusty, bad enough to require dust mask or goggles? Do objectionable fumes generate by test items cause any problems: Explain. Do fumes irritate eyes, respiratory tract, skin?
2.4 Noise	Does noise interfere with vocal communication? Any painful or uncomfortable noise levels? Any after effects from noise? Any need for ear plugs, etc?
2.5 Visibility	Any visibility problems in operation of the test item?

HUMAN FACTOR	POSSIBLE CONDITION
	Any difficulty reading gages, indicators, instruction plates? Any problems due to contrasting brightness levels, glare, reflections? Does airborne dust interfere with visibility? Do dust accumulations affect vision? Does hot-climate operating mode alter visibility?

3. Record below any comments to paragraph 2 above.

Paragraph No.	Comment

APPENDIX I

SAFETY CHECKLIST

Item Characteristics	Adequate	Inadequate	Ambiguous	Hazardous	Unnecessary
Clear identification of item					
Presence of safety warnings					
Adequacy of handling instructions					
Safety of handling procedures					
Presence of safety devices					
Sharp projecting edges, controls, etc.					
Access to emergency cut-off controls					
Replaceable safety devices					
Adequate instructions for dealing with emergency actions					
Adequacy of personnel operating instructions (from point of view of safety with respect to heating conditions present during desert testing).					
Interior and exterior temperatures of test equipment relative to ambient conditions					

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13 ABSTRACT

~~This~~ Environmental Test Procedure established test methods and techniques to evaluate the capability of electronic equipments (communication, surveillance, and avionic electronics) to function effectively against all known conditions in the desert which might have significant effects on the performance characteristics of the equipment. ( )

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